Coordinated Response to Recommendations and Issues Made by NCAR/CAS, CDP, CCR and NOAA/OAR/CDC for NWS STIP Climate Update

Jiayu Zhou, Climate Lead in NOAA/NWS/OST12, visited NCAR/CAS, CDP, CCR and NOAA/OAR/CDC for the NWS Science and Technology Infusion Plan (STIP) Climate Part Update on 19 June 2003. In a summary, five recommendations and eight issues made by NCAR and CDC were reported. The OST asked for feedbacks from NCEP operational centers. This is a coordinated response as a follow-up report.

Response to recommendations

- ***Recommendation (Rcd):*** The routine attribution study proposed by CDC and funded by OGP should be a part of the STIP. It is designed as a complementary performance measure by conducting the posteriors analysis to understand the climate predictability.

  Response (Rsp): CPC and CDC have a collaborative effort in model based seasonal attribution activity currently funded by OGP. Part of effort is documented at:

  http://www.emc.ncep.noaa.gov/cmb/atm_forecast/consortium/

  It will be included in the NWS STIP Climate.

- ***Rcd:*** The STIP performance measure should also examine the impact of new tools being introduced into the operation as an assessment to the science and technology infusion.

  Rsp: We agree that NOAA needs to come up with ways to document improvements of its seasonal forecast methodologies, i.e., GPRA measure for the seasonal prediction of surface temperature. This score is supposed to have a slow upward trend, presumably because of improvements in the seasonal prediction methodologies. On the other hand, our current GPRA measure is heavily influenced by predictable and unpredictable climate regimes over which forecasters have no control, and does not reflect changes/improvements in the forecasting techniques. We have been in contact with CDC in an attempt to formulate better performance measures.

- ***Rcd:*** Trenberth pointed out new problems in the current CDAS/reanalysis products and suggested to assess the effects of the continually changing observing system through routinely conducting observing system experiments. There may be problems with the current CDAS/reanalysis products beginning late 2000, perhaps in association with the introduction of ATOVS.

  Rsp: The sensitivity of CDAS to TOVS retrieval is a problem, which was found in earlier periods too. We made with/without satellite assimilation runs to learn what happens and knew climate shifts from changes in TOVS retrieval processing. E-mails were received, asking about the late '90-s/2000's CDAS temperature trends. However, it is impossible to "fix" the TOVS retrieval procedure as NESDIS algorithms improve in response to new techniques and satellite instruments.

  We also looked at the problems with the ~100 mb temperature trends in the 2000+ period and attributed the problems to the changes in the observation data (RTOVS/ATOVS). TOVS is a major factor in the stratospheric temperatures and its biases change with time.

  Sensitivity of reanalysis to TOVS retrievals can be much reduced by going to a direct assimilation of radiances as done by the current global system. This is one of the improvements for the next global reanalysis. As for OSE CDAS experiments, only limited number can be done. CDAS is using NCEP operation system for preparing the

input data sets. Only a 1/4 fte can be used for CDAS operations/updates/archive/web/email.

More attention should be placed on biases of the various instruments and how we correct the data before using them in the data assimilation systems. This would require much effort. Instrument specialists should work with data assimilation experts to improve characterization of all components of the changing observing system.

- ***Rcd:*** To improve the model, NCAR strategy is to make everything available to users, which include many research institutes and universities, and identify problems from their feedbacks. The NCEP/EMC should reach out to improve NCEP model, though individual situation could be different.

  Rsp: The NCEP model predictions are utilized and assessed by a wide spectrum of the user community. Such assessments and feedbacks are an important aspect of our model development process. To support the NCEP Global Forecast System as a publicly available code and respond to inquiries and user feedback on system performance, it needs a well-funded mechanism. As it now stands, EMC's resources aren't sufficient to diagnose the forecast system, repair it, evaluate it and prepare it for operations and support the community. NCEP does not have a support system as that NCAR has dedicated to interfacing its modeling system with the community.

- ***Rcd:*** To develop a strategy of model assessment, it is necessary to establish a common list of physical and dynamical processes or variables, which are able to help to understand the model deficiencies. This list should be contributed and fully discussed by modeling experts.

  Rsp: In view of future unified model approach and common model infrastructure, we have suggested a high level model assessment by scientists, who have no vested interests in particular models. The practice should ensure mutual interests and activities of the major centers and their scientists in **a community effort** that isolates strengths and short comings of models in the simulation of weather and climate regionally and globally. Unlike the AMIP, which is more focused on the accuracy of the climate simulation from model user perspective, this high level model assessment is to **aim at simulation of basic physical and dynamical processes from modeling perspective**. Through inter-model comparison, modelers would also be able to distinguish common versus individual model problems, and may learn clues toward the solution. The NCEP is committed to collaborate with major centers to develop and run diagnostic packages, which can be applied to various models, for inter-model comparisons and take related actions needed to improve the various systems.

Response to issues

- ***Issue (Iss):*** Currently, there are no formal programs to support week-2 forecast. The resource issue for the STIP should be addressed.

  Rsp: The NWS/OST is engaging scientific communities in developing a mechanism, which encourages science issues to be freely discussed and new methodologies tested by well organized diagnostic and modeling studies supported by NOAA annual budget and relevant programs. As Robert Livezey, NOAA Climate Board Member, indicated the NOAA Climate Board will ensure that STIP needs are addressed in the FY06 process. NCEP has formally agreed to implement CDC week-2 forecasts in its operational suite. This should happen within next 6 months and will be a great example of transfer of technology from research-to-operations.

- ***Iss:*** For the problem of current GPRA performance measure, Trenberth noted that part of the problem lies in how skill is defined. Skill relates to a signal to noise ratio and how well the signal is predicted. If there is no signal, NCEP has no control over that. It only has control over the noise in the forecast. He suggested that the metric should be re-examined.

  Rsp: As noted in reply to the recommendation #2 above, we are aware of inadequacy in our current GPRA measure. As formulated, it is heavily influenced by the changes in climate regimes which may have different level of predictability. In general, forecasters have no control over the level of expected prediction skill. On the other hand, GPRA has a slow upward trend. This upward trend should be due to increased in forecast technology, and not because of more predictable climate regimes. To borrow an analogy, steady improvement in the day 5 anomaly correlation skill score is due to improved observations, improved data assimilation techniques, and improvements in the atmospheric general circulation models. Our present GPRA measure may not be capable of documenting similar improvements in the seasonal prediction methodologies, and may need to be modified.

- ***Iss:*** The skill score for the 6 months lead forecast of SST anomaly averaged over the El Niño region is seasonally dependent. It is not clear if the current skill score shown in the first version of the NWS STIP Climate (September 2002) is for a particular season or for the annual mean. It may also be important to add the performance measure of root mean square error in addition to the measurement of correlation. In addition, the area of global ocean should be considered to take account for the variability of major oceanic modes in different ocean basins.

  Rsp: The numbers are for the 6-month forecasts issued in June and July and verifying in DJF and JFM. This is the most important season for wintertime ENSO response, and passes the spring barrier in predictability. As a comment, recent DOC IG audit has recommended that the ENSO skill measure be removed as a NOAA GPRA measure.

- ***Iss:*** For the week-2 forecast, Tribbia called attention to the break of intraseasonal oscillation regime. He showed the NCAR CCM3 forecast skill degraded immediately after the phase transition. The similar behavior has also been confirmed in the NCEP and ECMWF models.

  Rsp: The impact of the weather regime break on the extended range prediction, which influences the week-2 forecast, is a longstanding issue, has been well recognized by practitioners at NWS/CPC. The actual predictability beyond the break depends strongly on the timing of the break. If the break occurs early (within 5 days), and is followed by a more stable regime, there still is a significant amount of predictability left due to the memory of the initial condition, and skill after 5 days may actually be about average. If the break occurs late, like during week2 itself, the forecasts can be disastrous. So yes indeed, the forecast of breaks, however defined, is a main issue.

- ***Iss:*** The NCEP/EMC recent improvement in the couple model simulation is impressive. Since increased levels are mainly above troposphere, one possibility could be related to the sigma coordinate problem in the model upper layer. Using more levels could relieve the upper boundary condition problem.

  Rsp: It is possible that adding more vertical levels may relieve the upper boundary condition problem that Kevin Trenberth noted in the stratosphere of the sigma-level based model. If we decide to make another re-analysis, we will be using at least 64 layers in the vertical (the same as the tested coupled model). We have noticed improved stratospheric analysis

and forecasts when compared the result of 64-layer system with that of the 42-layer system in 2001, before the 64-layer system became operational in the GFS.

- ***Iss:*** Trenberth showed his recent work on diagnosis of NCAR CCSM2 problems. One of the issues is that the convection starts too early in the model, not allowing CAPE to build up before initiation of the convection, and the triggering mechanisms (which could be gravity wave, dry line, gust front, etc.) is not correctly simulated (Dai and Trenberth 2003). This problem could be common to other models.

  Rsp: This is true of some model's convective scheme, which tends to trigger convection over a larger area and producing relatively weak precipitation rates. This is not always the case, however, with mass flux convective schemes. The answer here is more complicated, and it depends on the situation and what amount of tuning is done to the scheme for a particular model resolution.

  The danger of delaying the triggering (initiation) of convection and allowing energy (e.g., CAPE) to be stored is that the model is much more likely to produce spurious precipitation maxima (so-called "grid-scale bombs"), in which the grid-scale microphysics removes the water vapor and the instability at very rapid rates. It is extremely difficult for a convective scheme to trigger just at the point of unconditional instability without going "over the edge" and producing unrealistically high amounts of rain over too small an area over too short a time.

  There is an example of where the GFS produces grid-scale bombs, which go away (or at least are more realistic) when the RSM (Regional Spectral Model) is run at high resolution. The precipitation looks convective, but is mostly grid-scale in nature, even though the initial development of the clouds was probably produced by the convective scheme. Interactions between convective and grid-scale processes are particularly difficult, but they are also of great interest and quite relevant to all scales of atmospheric modeling.

- ***Iss:*** Currently, OAR does not have the focal point for the water cycle and should build the link to the R&D needs for the water forecast and application.

  Rsp: This issue has been reported to the NOAA Climate Office.

- ***Iss:*** The solar forcing could be already built into the initial condition, when looking for the seasonal influence. While, how much could be impacted by the dynamical feedback process in association with ocean-land-atmosphere coupling that needs further investigation.

  Rsp: Issue of changes in the solar forcing on seasonal climate variability is still an open issue and needs to research further. Atmospheric general circulation model based sensitivity experiments should be one way to help resolve this issue. How does solar activity influence seasonal variability, and what is its geographical distribution, needs to be better understood. If the impact of changes in the solar activity through changes in the sea surface temperatures (SST), then as stated above, such an influence should already be built into the SST observations. On the other hand, if the influence of the changes in the solar forcing is dynamical (e.g., via changes in the stratospheric circulation and stratospheric-tropospheric coupling), an improved understanding for this process will be needed before it can be applied to improving seasonal predictions. We are interested in the result coming out of the research in future.